EPIZOOTIOLOGY OF HUMAN BABESIOSIS

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Although babesiosis is the first disease of vertebrates proven to be transmitted by blood-feeding vectors (Smith and Kilbourne, 1893), only recently has this tick-borne infection become recognized as a cause of pathology in apparently normal human beings. Since 1958, at least 5 splenectomized persons have become ill due to infection with *Babesia* parasites, mostly of bovine origin (cited in Anderson et al., 1974; Gorenflot et al., 1976). Although sporadic asymptomatic infections have been reported (Healy et al., 1976a; Osorno et al., 1976; Leeflang et al., 1976), frank disease in spleen-intact persons seems limited to islands near Cape Cod, Massachusetts. We know of 17 such cases, 15 occurring within the last two years and 12 occurring on Nantucket Island. *Babesia microti*, a cosmopolitan parasite of small rodents, is the etiologic agent for this unique cluster of human infections (Healy et al., 1976b). Accordingly, we studied the epizootology of babesiosis on Nantucket and nearby islands.

In identifying local reservior hosts for *B. microti*, relatively few candidates need be considered because the mammalian fauna of Nantucket is limited. The white-footed mouse (*Peromyscus leucopus*) and the meadow vole (*Microtus pennsylvanicus*) are abundant as are cottontail rabbits (*Sylvilagus floridanus*) and the white-tailed deer (*Odocoileus virginianus*). Aside from introduced feral rodents and carnivores, few other mammals are common. Rate of infection was measured by inoculating heart blood removed from wild-caught animals. More than three quarters of hamsters became parasitemic after being inoculated with blood from white-footed mice taken from enzootic areas on Nantucket. A lesser proportion of voles carry the infection. Infection in rabbits is rare and the parasite is apparently absent in deer.

In order to compare intensity of parasitemia in potential reservoir hosts, direct smears were prepared from the blood of wild-caught animals. This method for recognizing infection was much less effective than was inoculation of hamsters, revealing less than a third of infections demonstrable by inoculating hamsters. Only once, in a juvenile vole, was the parasitemia intense. Prevalence in mice as measured by direct smear varied with season, reaching maximum levels during mid-summer.

Geographical distribution of infected mice was measured by inoculating hamsters. In general, *Babesia* infection was evident solely in coastal regions where deer were abundant. Thus, various islands appeared to be free of infection as were certain locations on Cape Cod and the mainland.

Relatively few species of ticks are present on Nantucket Island and only two were discovered on white-footed mice: *Dermacentor variabilis* and *Ixodes scapularis*. *I. scapularis* predominates on the mice while *D. variabilis* is more common on voles. Only immature ticks were found on the animals. These findings led to a laboratory study of transstadial passage of the infection in immature *I. scapularis* (Spielman, 1976) and this work established that nymphs of this tick are efficient vectors. *D. variabilis* seemed not to transmit the infection. Nymphal *I. scapularis*, derived from the field, transmitted *B. microti* to laboratory hamsters.

Although immature *I. scapularis* feed most commonly on white-footed mice and adults are most abundant on deer, host range is broad. Larvae and nymphs were abundant on deer and were found on voles, cottontail rabbits, rats, shrews, birds and were surprisingly common on man. Adults were common pests of dogs, cats and man.

The life cycle of *I. scapularis* appears to span 2–3 years on Nantucket Island. Larvae feed from April through September and are most abundant during July. Nymphs attach to mice from March through August with peak-feeding during May and June. Adults seek hosts during early spring and late fall. Thus, larvae feeding during one year produce nymphs which feed the following spring. These, in turn, molt to adults which feed that fall or the following spring. In this manner, the spring brood of susceptible mice are available to potentially infectious nymphs.

Ixodes scapularis, collected during this study, differ from those reported in the southeastern U.S. Morphologically, Massachusetts ticks are similar to those collected in Ontario, Wisconsin, New Jersey, Long Island, Connecticut and Rhode Island. Southern ticks range from Florida north to Virginia and west to Oklahoma and differ in that larvae and nymphs feed most commonly on reptiles (Rogers, 1953) instead of mammals. They rarely attach to man. We will propose, elsewhere, that these northern ticks be designated as a separate species.

It is curious that *I.* sp. nr. *scapularis* was not reported from Nantucket or Martha's Vineyard in the course of tick surveys performed there during the 1930's and 1940's (Hertig and Smiley, 1937; Smith, 1941) while being present on the nearby island of Naushon (Larousse, 1928; Smith, 1943). This may be explained by the scarcity of deer on Nantucket and Martha's Vineyard during this period. These mammals have since become abundant there. Before *I.* sp. nr. *scapularis* became abundant, *I. muris* was a common parasite of small rodents, but this species is now rare. Since *B. microti* was reported on Martha's Vineyard in 1938 (Tyzzer), *I. muris* may have served as an enzootic vector before *I.* sp. nr. *scapularis* became abundant. The wider host range of the latter species would increase risk of human infection.

Several characteristics of the present Nantucket environment appear to favor transmission of *B. microti* to man: (1) Deer are abundant. (2) People have increasing contact with the brush cover presently extending

throughout the island. (3) The mild oceanic climate favors large populations of ticks. In this environment, man's activities lead to intimate contact with large populations of infectious, nymphal, non host-specific ticks.

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